

Appl. No. 09/851,940  
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Reply to Office Action of May 5, 2004

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**Amendments to the Claims:**

Claims 1, 10, 13, and 22 have been amended. Claims 2-3, 7-9, 11-12, 14-15, 19-21, 23-24, 27-30 have been canceled without prejudice. This listing of claims will replace all prior versions, and listings of claims in the application:

**Listing of Claims:**

- 1 1. (Currently Amended) A method of analyzing intersections between objects in  
2 computer animation comprising:
  - 3 providing a plurality of objects represented by a plurality of meshes, with each of  
4 said plurality of objects being represented by one of said plurality of meshes and each of said  
5 meshes being formed by a set of vertices, where a set of pairs of vertices of said set of vertices  
6 define a set of edges;  
7 checking all edges of said meshes to determine if said set of edges of said meshes  
8 intersect with any of said plurality of meshes;  
9 tracing an intersection path formed by intersection of said edges with any of said  
10 plurality of meshes;  
11 determining which vertices of said meshes are contained within said intersection  
12 path, the determining comprising:
    - 13 selecting an arbitrary edge of a mesh that crosses said intersection path,  
14 where said arbitrary edge is formed by vertices  $u$  and  $v$  and where said mesh contains said  
15 intersection path;  
16 performing a search of said mesh, radiating from one of said vertices  $u$  and  
17  $v$ , identifying all vertices in all of said edges that cross said intersection path, and defining the set  
18 of vertices identified as a playpen;  
19 tracing said intersection path and identifying vertices, within said playpen,  
20 on a left side of said intersection path as left and retracing said intersection path in an opposite  
21 direction and identifying vertices, with said playpen, on a right side of said intersection path as  
22 right;

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23 determining whether vertices adjacent to vertices identified as left and  
24 right lie outside of said playpen;  
25 discarding said intersection path when at least one of both left and right  
26 identified vertices lie outside said playpen; and  
27 determining whether at least one vertex adjacent to said right identified  
28 vertices lies outside said playpen; and  
29 characterizing each of said left identified vertices as contained within said  
30 intersection path when at least one vertex adjacent to said right identified vertices lies outside  
31 said playpen and characterizing each of said right identified vertices as contained within said  
32 intersection path when at least one vertex adjacent to said left identified vertices lies outside said  
33 playpen; and  
34 setting a polarity of each vertex contained within said intersection path to indicate  
35 that said vertex is contained within said intersection path, wherein a polarity of a vertex is set  
36 based upon a number of disconnected regions formed by said intersection path.

1 2. (Canceled)

1 3. (Canceled)

1 4. (Previously Presented) The method of claim 1 wherein said intersection path is  
2 a self-intersection with the intersection path being contained in a single mesh and wherein setting  
3 a polarity of each vertex comprises:

4 associating a first color with each vertex that is contained within said intersection  
5 path when the intersection yields one region; and

6 when the intersection yields first and second disconnected regions, associating a  
7 second color with each vertex contained in said first disconnected region and associating a third  
8 color with each vertex contained in the second disconnected region.

1 5. (Previously Presented) The method of claim 1 wherein said intersection path is  
2 an intersection between a first mesh and a second mesh and wherein setting a polarity of each

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3 vertex comprises associating a first color with vertices of the first mesh contained within said  
4 intersection path and associating a second color with vertices of the second mesh contained  
5 within said intersection path.

1 6. (Previously Presented) The method of claim 4, further comprising displaying  
2 said objects on a computer display with vertices displayed in colors associated with the vertices.

1 7. (Canceled)

1 8. (Canceled)

1 9. (Canceled)

1 10. (Currently Amended) A method of simulating motion of objects in computer  
2 animation, the method comprising:

3 providing a plurality of objects represented by a plurality of meshes, with each of  
4 said plurality of objects being represented by one of said plurality of meshes and each of said  
5 meshes being formed by a set of vertices, where at least one of said objects is an animated object  
6 and at least one of said objects is a simulated object;

7 positioning said objects at some time  $t$  to provide one frame of said computer  
8 animation;

9 determining an intersection path formed by intersections between said objects;

10 setting a polarity of each vertex contained within said intersection path based  
11 upon a number of disconnected regions formed by said intersection path, wherein setting the  
12 polarity comprises:

13 when said intersection path is a self-intersection with the intersection path  
14 contained in a single mesh,

15 associating a first color with each vertex contained within said  
16 intersection path when the intersection yields one region, and

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17 when the intersection yields first and second disconnect regions,  
18 associating a second color with each vertex contained in said first disconnected region and a  
19 third color with each vertex contained in the second disconnected region; and

20 when said intersection path is an intersection between a first mesh and a  
21 second mesh, associating the second color with each vertex of the first mesh contained within  
22 said intersection path and associating a third color with each vertex of the second mesh contained  
23 within said intersection path;

24 setting a simulated force between vertices of said at least one simulated object  
25 based on the polarity set for said vertices of said at least one simulated object, wherein setting the  
26 simulated force comprises:

27 setting said simulated force to cause an attraction between vertices of said  
28 at least one simulated object when said vertices are associated with said second or third colors;

29 setting said simulated force to cause a repulsion between vertices of said at  
30 least one simulated object when said vertices are not associated with said first color, said second  
31 color, or said third color; and

32 setting said simulated force to cause neither an attraction or a repulsion  
33 between vertices of said at least one simulated object when said vertices are associated with said  
34 first color; and

35 advancing the computer animation to a time  $t + \Delta t$  and simulating motions of said  
36 objects using said simulated force to simulate motions of said at least one simulated object.

1 11. (Canceled)

1 12. (Canceled)

1 13. (Currently Amended) A computer program product stored on a computer  
2 readable medium for processing computer generated objects, said computer program product  
3 comprising:

4 code for providing a plurality of objects represented by a plurality of meshes, with  
5 each of said plurality of objects being represented by one of said plurality of meshes and each of

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6 said meshes being formed by a set of vertices, where a set of pairs of vertices of said set of  
7 vertices define a set of edges;  
8 code for checking all edges of said meshes to determine if said set of edges of said  
9 meshes intersect with any of said plurality of meshes;  
10 code for tracing an intersection path formed by intersection of said edges with any  
11 of said plurality of meshes; and  
12 code for determining which vertices of said meshes are contained within said  
13 intersection path, the code for determining comprising:  
14 code for selecting an arbitrary edge of a mesh that crosses said intersection  
15 path, where said arbitrary edge is formed by vertices  $u$  and  $v$  and where said mesh contains said  
16 intersection path;  
17 code for performing a search of said mesh, radiating from one of said  
18 vertices  $u$  and  $v$ , identifying all vertices in all of said edges that cross said intersection path, and  
19 defining the set of vertices identified as a playpen;  
20 code for tracing said intersection path and identifying vertices, within said  
21 playpen, on a left side of said intersection path as left and retracing said intersection path in an  
22 opposite direction and identifying vertices, with said playpen, on a right side of said intersection  
23 path as right;  
24 code for determining whether vertices adjacent to vertices identified as left  
25 and right lie outside of said playpen;  
26 code for discarding said intersection path when at least one of both left  
27 and right identified vertices lie outside said playpen;  
28 code for determining whether at least one vertex adjacent to said right  
29 identified vertices lies outside said playpen; and  
30 code for characterizing each of said left identified vertices as contained  
31 within said intersection path when at least one vertex adjacent to said right identified vertices lies  
32 outside said playpen and characterizing each of said right identified vertices as contained within  
33 said intersection path when at least one vertex adjacent to said left identified vertices lies outside  
34 said playpen; and

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35 code for setting a polarity of each vertex contained within said intersection path to  
36 indicate that said vertex is contained within said intersection path, wherein a polarity of a vertex  
37 is set based upon a number of disconnected regions formed by said intersection path.

1 14. (Canceled)

1 15. (Canceled)

1 16. (Previously Presented) The computer program product of claim 13 wherein  
2 said intersection path is a self-intersection with the intersection path being contained in a single  
3 mesh and the code for setting a polarity of each vertex comprises:

4 code for associating a first color with each vertex that is contained within said  
5 intersection path when the intersection yields one region; and

6 when the intersection yields first and second disconnected regions, code for  
7 associating a second color with each vertex contained in said first disconnected region and  
8 associating a third color with each vertex contained in the second disconnected region.

1 17. (Previously Presented) The computer program product of claim 13 wherein  
2 said intersection path is an intersection between a first mesh and a second mesh and the code for  
3 setting a polarity of each vertex comprises code for associating a first color with vertices of the  
4 first mesh contained within said intersection path and code for associating a second color with  
5 vertices of the second mesh contained within said intersection path.

1 18. (Previously Presented) The computer program product of claim 16, further  
2 comprising code for displaying said objects on a computer display with vertices displayed in  
3 colors associated with the vertices.

1 19. (Canceled)

1 20. (Canceled)

1 21. (Canceled)

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1                   22. (Currently Amended) A computer program product stored on a computer  
2 readable medium for processing computer generated objects in computer animation, said  
3 computer program product comprising:  
4                   code for providing a plurality of objects represented by a plurality of meshes, with  
5 each of said plurality of objects being represented by one of said plurality of meshes and each of  
6 said meshes being formed by a set of vertices, where at least one of said objects is an animated  
7 object and at least one of said objects is a simulated object;  
8                   code for positioning said objects at some time  $t$  to provide one frame of said  
9 computer animation;  
10                  code for determining an intersection path formed by intersections between said  
11 objects;  
12                  code for setting a polarity of each vertex contained within said intersection path  
13 based upon a number of disconnected regions formed by said intersection path, wherein the code  
14 for setting a polarity of each vertex comprises:  
15                   when said intersection path is a self-intersection with the intersection path  
16 contained in a single mesh,  
17                   code for associating a first color with each vertex contained within  
18 said intersection path when the intersection yields one region and  
19                   when said intersection path yields first and second disconnected  
20 regions, code for associating a second color with each vertex contained in said first disconnected  
21 region and a third color with each vertex contained in the second disconnected region; and  
22                   when said intersection path is formed from an intersection between a first  
23 mesh and a second mesh, the code for setting a polarity of each vertex contained in said  
24 intersection path comprises code for associating the second color with each vertex of the first  
25 mesh and associating the third color with each vertex of the second mesh;  
26                  code for setting a simulated force between vertices of said at least one simulated  
27 object based on the polarity set for said vertices of said at least one simulated object, wherein the  
28 code for setting a simulated force comprises:

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29 code for setting said simulated force to cause an attraction between  
30 vertices of said at least one simulated object when said vertices are associated with said second  
31 or third colors;  
32 code for setting said simulated force to cause a repulsion between vertices  
33 of said at least one simulated object when said vertices are not associated with said first color,  
34 said second color, or said third color; and  
35 code for setting said simulated force to cause neither an attraction or a  
36 repulsion between vertices of said at least one simulated object when said vertices are associated  
37 with said first color; and  
38 code for advancing the computer animation to a time  $t + \Delta t$  and simulating  
39 motions of said objects using said simulated force to simulate motions of said at least one  
40 simulated object.

1 23. (Canceled)

1 24. (Canceled)

1 25. (Previously Presented) The method of claim 5, further comprising  
2 displaying said objects on a computer display with vertices displayed in colors associated with  
3 the vertices.

1 26. (Previously Presented) The computer program product of claim 17, further  
2 comprising code for displaying said objects on a computer display with vertices displayed in  
3 colors associated with the vertices.

1 27. (Canceled)

1 28. (Canceled)

1 29. (Canceled)

1 30. (Canceled)